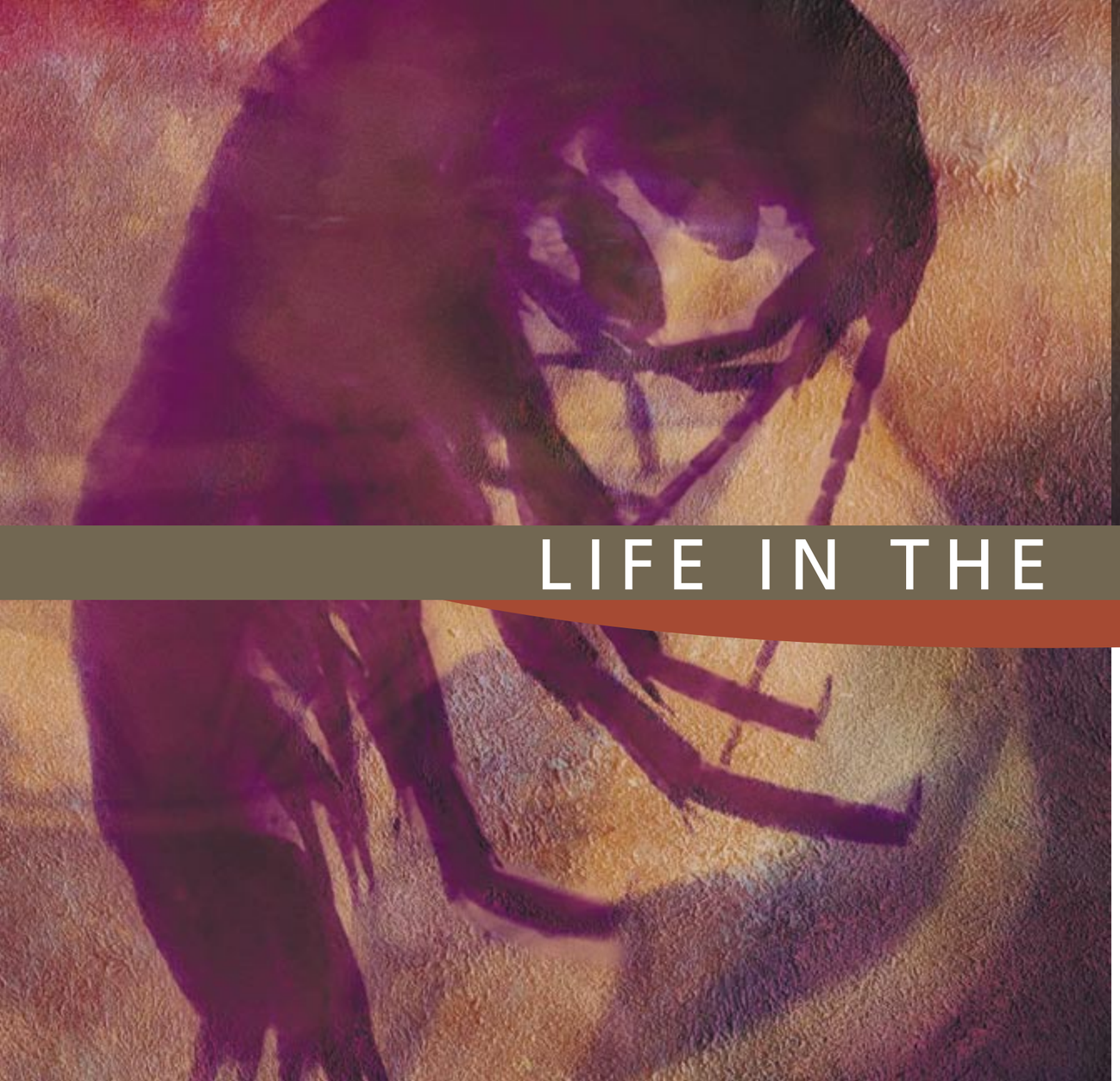

To effectively protect animals, we must protect their habitats. However, for animals that live underground and are not easily found or seen, protecting their habitats is especially important and difficult. In and around the nation's capital, urban development over the past 100 years has obliterated many subterranean aquatic habitats by water contamination, fill, pavement, and entombment in pipes or concrete. As a result, development has eliminated or so disturbed many groundwater systems that unknown numbers of interesting and potentially significant species are lost.

LIFE IN THE UNDERGROUND

The National Parks of the National Capital Region protect fragile and fragmented groundwater habitats that house truly remarkable creatures. Along the Potomac River and its tributaries, including Rock Creek, the groundwater is home to a diverse community of animals without backbones (invertebrates), such as snails and several kinds of crustaceans. Amphipods are among the largest groups of freshwater invertebrates in North America (Culver and Sereg 2004). These blind, colorless, shrimp-like animals only live underground. Remarkably, work by Culver and Sereg (2004), biologists from American University, revealed that the Region's parks are one of the hotbeds of amphipod biodiversity for the genus *Stygobromus*. Seven *Stygobromus* species are known to occur in the groundwaters of the parks.

Protection of *Stygobromus* species of amphipods is challenging because they live underground in scattered small habitats. Understanding the distribution of these subterranean species is important for Park managers to ensure that resource management practices protect the invertebrate habitat. Management practices that address the protection of groundwater habitat are especially needed because the federally endangered Hay's Spring amphipod (*Stygobromus hayi*) and other *Stygobromus* amphipod species of conservation concern occur in several of the Region's parks.

The Hay's Spring amphipod and Kenk's amphipod (*Stygobromus kenki*) are endemic to Rock Creek. This means that those two amphipods are found only along Rock Creek and nowhere else in the world. Hay's Spring amphipod reaches 0.4 inch (10 mm) in length.

Above: *Dr. Culver and students, American University, sample amphipods from the Rock Creek stream underflow.*

Little is known about its biology, ecological community, or population dynamics. Kenk's amphipod is half the size of Hay's Spring amphipod, and less is known about this species. Kenk's amphipod is highly rare and critically imperiled within the District of Columbia.

The life histories of many underground dwelling animals are still a mystery. Amphipods and other invertebrates live in seeps and small springs, which are fed by precipitation, surface flows, or groundwater. Amphipods are also found in small, clay-lined, perched aquifers, as much as 39 inches (1 meter) deep. Since the clay prevents the downward movement of water, the water becomes perched. The clay layer may also serve as a refuge for amphipods to burrow into during drought.

Amphipods move within the water as it percolates among sand grains and gravel. Seeps may have semi-isolated areas of saturated soil and gravel where amphipods live. The seep environment is a complex

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area of upwellings and downwellings of water that produce pockets of low and high oxygen content within just a yard (meter) of one another (Mestrov 1962). In seeps and springs, large volumes of water may flush the animals up and out. Although amphipods may be found washed out into the fallen leaves and debris around a spring or seep, these outflow areas do not support survival or dispersal. Because perched aquifers are usually isolated underground, they provide limited opportunity for dispersal.

While it is not entirely clear where amphipods live, the most likely habitat for survival and dispersal is along the underflows of the river, streams, and spring runs, where they probably inhabit two types of underflow habitats: (1) bedrock fractures that are flooded [called stream underflow habitat], and (2) in the surface soil, gravel, and rocks above the bedrock [called seep underflow habitat]. These are all called interstitial habitats, which are narrow spaces filled with water among the rock, gravel, and sand (Culver and Sereg 2004).

Rock Creek's Amphipods

Examples of the two types of underflow habitats where amphipods may live occur in Rock Creek Park. The stream underflow habitat is found beneath and along Rock Creek's stream bed and beneath the upland springs in the park. The seep underflow habitat is scattered throughout the Park and is found where subsurface water is retained at shallow depths below the soil layer in loose rock piles or in fractures within superficial rock layers.

Culver and Sereg began surveying groundwater habitats located in Rock Creek Park in 2000 to ascertain the presence and composition of the groundwater invertebrate community. Sampling for amphipods is usually restricted to monitoring spring outflows by baiting with shrimp or searching through dead leaves for invertebrates. For this study, they used a special pump designed by French biologists, Claude Bou and Raymond Rouch, to extract invertebrates in the stream underflow habitat. Bou-Rouch pumping proved to be a very successful sampling technique. It pulled up more species of groundwater invertebrate fauna than baiting with shrimp or searching beneath leaves at spring outflows did. However, the pump could not be used in spring runs associated with storm drains because it clogged from the high amounts of fine sediments. In addition to counting and identifying all amphipods found, Culver and Sereg evaluated environmental threats, identified ecological tolerances of the amphipods, and described the ecological diversity and health of groundwater habitats in nine springs and four sites along Rock Creek.

Five of the nine springs in Rock Creek Park (stream underflow habitats) have two or more amphipod species and show the fewest signs of anthropogenic influences, indicated by lower amounts of dissolved solids (a measure of pollution) and nitrate (0.26 to 4.4 mg/L). It is important to define the recharge areas for these sites and designate them as Special Protection Areas within the Park. The remaining four springs contained low numbers (0 or 1) of amphipod species and showed signs of high anthropogenic influence with greater degradation in water quality. These springs are close to a heavily traveled city street and highly developed urban neighborhoods. Culver and Sereg measured extremely high nitrate values, ranging from 8.87 to 30.8 mg/L. High nitrate values may be a result of runoff of lawn chemicals and fertilizers from the surrounding neighborhoods.

Culver and Sereg (2004) found that the seep underflow habitats supported 22 invertebrate taxa total. The list included the Potomac Groundwater amphipod (*Stygobromus tenuis potomacus*).The Potomac Groundwater amphipod is widespread in the Park and needs no special protection, although it remains a Watch List species for Maryland and the District of Columbia.

Rock Creek Park Natural Resource Manager examines preserved specimens of amphipods.

Urban Parks Host Rare Species

Rock Creek Park is one of the oldest National Parks, established in 1890, and one of the largest urban parks in the United States. It encompasses 1,754 acres (709.8 ha) of Rock Creek's rugged stream valley, protecting significant natural resources. The Park has survived urban development pressures from the surrounding neighborhoods of Washington, D.C. and provides valuable plant and wildlife habitat. Nestled in the nation's capital, Rock Creek Park has a surprisingly rich diversity of native species, including species listed as rare and imperiled within the District of Columbia: six invertebrates, 53 plants, and one bird. Rock Creek is a wildlife corridor, descending from 165 feet (50.3 m) at the Maryland border to approximately sea level where it enters the tidal Potomac River. Continuous threats to the Park's natural resources challenge managers to distribute funds based on conservation need and importance.

Top: Seeps are very vulnerable to degradation caused by hikers diverging from trails.
Bottom: Amphipods washed out into fallen leaves and debris do not survive.

The stream underflow habitats of the springs had the greater number of invertebrate taxa at 25, demonstrating that it is in better condition compared to the stream underflow habitat of Rock Creek, which had only 13 taxa total (Culver and Sereg 2004). Culver and Sereg (2004) found three species endemic to the wider Rock Creek Park area at four or fewer sites. Kenk's and Hay's Spring amphipods occurred in the stream underflow habitats and less frequently in the seep underflow habitats. They found Hay's Spring amphipod, but not Kenk's amphipod in the Rock Creek stream underflow habitat. An undescribed amphipod species was more rare and found only once in each of the stream underflow habitats of Rock Creek and the upland springs.

> "The persistence of amphipod populations in the National Capital Region is testament both to the protection of habitat set aside in National Parks and to the critical importance that the Park has placed on preserving these species."

This study demonstrated that Kenk's amphipod has a smaller range (1.9 miles (3 km)), stretching along one side of Rock Creek drainage than the federally listed Hay's Spring amphipod (6.2 miles (10 km)), which extends along both sides of Rock Creek drainage. It is unlikely that Kenk's amphipod uses the Rock Creek stream underflow habitat to disperse; it may have very limited dispersal ability (Culver and Sereg 2004). Habitat degradation may be the most important factor in the rarity of Kenk's amphipod.

Amphipods have little capability to respond to environmental degradation, which makes them extremely vulnerable to impacts like storm water runoff, pollution from road runoff, and soil compaction from trails. The seeps, their underground flows, and their catchment basins face several kinds of direct threats. Walkers on trails through seep areas compact the soil, reducing the amount of suitable habitat. To protect the subterranean fauna in the stream underflow habitat of seeps and springs, creating new trails and the widening of existing trails in these areas need to be avoided. Runoff from nearby streets may be especially harmful because of the elevated levels of heavy metals such as selenium and lead from tire residue. Pesticide applications that could harm subterranean invertebrates should be prohibited in all spring and seep recharge areas.

An additional concern is that the current practice of routing storm water into small stream channels in the parks clogs the streambeds with very fine particles, such as clay and silt. Clogging by sediments has effectively eliminated these streams as dispersal paths for amphipods and isolated the seeps along the stream, degrading groundwater habitat. It is important to remove or divert storm drains that impact spring sites.

Bill Yeaman, Rock Creek Park Natural Resource Manager, shows one of the many seeps scattered throughout Rock Creek Park, which provide habitat for rare amphipods.

The persistence of amphipod populations in the National Capital Region is testament both to the protection of habitat set aside in National Parks and to the critical importance that the Park has placed on preserving these species. Detailed information on the distribution of these amphipod species has resulted in changes in resource management, including rerouting of storm water runoff, changing road maintenance practices, altering the location of new trails away from seeps and springs, building small foot bridges over seeps, and restoring vegetation around some seep areas.

The small parks in the Region are protecting wildlife habitat, as well as the interrelationships among the natural processes and the species they support. Baseline studies like Culver and Sereg (2004) are very important for understanding how to manage park resources and to ensure the persistence of a rich diversity of amphipod species that face continued threats from urban development pressures. Dr. Culver expanded the survey in 2004 to include George Washington Memorial Parkway, and in 2006 he and his students will continue along the Parkway and begin studying amphipods in three more national parks on the Coastal Plain: the Chesapeake and Ohio Canal National Historical Park, Manassas National Battlefield Park, and Prince William Forest Park. Parks of the National Capital Region provide some of the few remaining places where these small, special habitats, and the wildlife they support, can be found.

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CENTER FOR URBAN ECOLOGY

Threatened and Endangered Species Program The Threatened and Endangered Species Program at the Center for Urban Ecology supports conservation efforts for threatened and endangered species of the National Capital Region. The Threatened and Endangered Species Program protects five federally listed species along with State-listed species through research, reintroduction, monitoring, and invasive plant management. The Region has two federally threatened species: bald eagle (*Haliaeetus leucocephalus*) and small whorled pogonia (*Isotria medeoloides*) and three endangered species: harperella (*Ptlimnium nodosum*), Hay's Spring amphipod (*Stygobromus hayi*), and shortnose sturgeon (*Acipenser brevirostrum*). The Threatened and Endangered Species Program assists parks with compliance under Section 7 of the Endangered Species Act. The National Capital Region cooperates with the lead biologists for these listed species in state and federal agencies, working toward the species' recoveries. Conservation strategies are necessary to sustain healthy populations and recover listed species within the parks. Parks provide information annually to Congress on the status of the parks' listed species and the amount spent on monitoring and recovery efforts.